

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

No. 17. MAY 1879.

XXXVI.—*Descriptions of new Species belonging to the Genus Solenopus, with some Observations on their Organization.*
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It is about thirty years since one of us (Koren) first found the animal which will be described below under the name of *Solenopus nitidulus*. Koren's investigations, however, went no further at that time than to convince him that it was a mollusk; for he had not sufficient material for a more thorough-going examination. Some years later it was also found by our late friend Prof. M. Sars; but he got no further than Koren, having only one specimen at his disposal. Nevertheless he quite agreed with Koren that the animal must be referred to the Mollusca. In the course of years we found single examples in various localities; and these we submitted to investigation, as it was our purpose to produce a monographic description of this remarkable animal. But the difficulties in the way of submitting it to a minute anatomico-histological examination, combined with the extremely scanty material at our disposal, led to our deferring the final working up, so as not to furnish a misleading work. During the last three or four years Prof. G. O. Sars, who knew that we had

* Translated by W. S. Dallas, F.L.S., from a separate copy of the paper in the 'Archiv for Mathematik og Naturvidenskab,' Christiania, 1878.

been occupying ourselves for a long time with the animal in question, most kindly furnished us with numerous specimens, many of which, however, are of different species; and we commenced our investigations, which are now so far advanced that we can give a brief description of the forms of which we are in possession, in the hope, however, that, in the course of next year, we shall be able to complete a more exhaustive memoir, accompanied by figures. That this abridged description makes its appearance now is owing to the fact that we are urged thereto by Prof. G. O. Sars, who is just engaged upon a work on the Arctic mollusk-fauna, in order that he may be able to include in the latter the arctic species of this genus.

But although we, at intervals of many years, have only had scanty opportunities of occupying ourselves with the animal under consideration, seeing that we very seldom found it and then only in isolated examples, it has nevertheless, during the long period which has elapsed since Koren first met with it, been detected by other naturalists, such as, especially, the older and younger Sars, Dalyell, S. Lovén, and T. Tullberg. Dalyell, in the 'Powers of the Creator,' has given a description with figures of the animal, which he refers to the Vermes, and calls *Vermiculus crassus* *. There is no doubt that this belongs to the molluscan genus that we describe below; and, so far as we can judge from Dalyell's description and figures, it is probably the species to which we have given the name of *Solenopus Dalyellii*. If we had not feared that the generic name *Vermiculus* would lead to error and confusion, we should have retained it for our mollusk, as it had the priority of date; but, in order to avoid all such dangers, we have adopted M. Sars's name, both for the genus and for the single species which was known at that time, namely *Solenopus nitidulus* †. Sars, indeed, has not given any description of the animal; so that it was not well possible for any one but ourselves, who were acquainted with it, to know what animal was meant by *Solenopus nitidulus*; and it is certainly only this circumstance that has caused Hr. Tullberg not to adopt Sars's designation, but to give it a new name (*Neomenia carinata* ‡). If we now adopt Sars's name, it is both because it has the right of priority and because it applies better to the genus, which is essentially characterized by the

* 'The Powers of the Creator,' vol. ii. p. 88, pl. x. fig. 11.

† Forhandl. i Videnskabs-Selsk. i Christiania, Aar 1868, p. 257.

‡ Bihang til Svenska Vet.-Akad. Handl., Band iii. no. 13; "*Neomenia*, a new Genus of Invertebrate Animals," by Tycho Tullberg.

furrow (fissure) which occurs on the ventral surface, and within which the foot is concealed; there is, so to speak, a cleft for the foot; whereas "crescent" (*Neomenia*) really only applies to the species which Hr. Tullberg has described after the animal is preserved in spirits; for in the living state it has properly no crescent-shape; and as regards the other six species now described by us, it does not at all apply to them.

We have already stated that Koren and M. Sars regarded *Solenopus nitidulus* as a mollusk; and our subsequent investigations have most decidedly confirmed this. But, as it differs considerably from previously known mollusks, we have not been able to bring it under any of the established orders of Mollusca, although it may well be referred to the great subclass Opisthobranchiata of Milne-Edwards. We have accordingly formed for it a third order of Opisthobranchiata, which we have called Telobranchiata*, because the branchiæ are situated at the hinder extremity of the animal.

After what we have said above, of course we have been unable to adopt Dr. Ihering's classification † with regard to the mollusk here treated of; for, although there is an anomaly in the generative organs of *Solenopus nitidulus*, which might indicate that, from a phylogenetic point of view, it was derived (had descended) from the Platyelmia, it is nevertheless certain that it is a true mollusk, and may be classified as such.

We shall follow the brothers H. and A. Adams's classification of the Gasteropoda.

Subclass OPISTHOBRANCHIATA, Milne-Edwards (1848).

Order 3. *TELOBRANCHIATA*, Koren and Danielssen.

The Telobranchiata are naked marine animals, with more or less worm-like bodies. They are hermaphrodite, and have neither tentacles, eyes, radula, or jaws. The foot is long and narrow, and can be completely concealed by the mantle. The branchiæ, which are placed at the posterior extremity of the animal, are retractile. Heart with a pretty well developed vascular system. Body-cavity almost entirely filled by the visceral mass. Generative organs situated along the back, above the stomach and intestine. Nervous system composed

* From *τέλος*, end, and *βράγχια*, gills.

† *Jahrbücher der Deutschen malakozoologischen Gesellschaft*, 1876, Heft ii. p. 136; *Vergleichende Anatomie des Nervensystems und Phylogenie der Mollusken*, von H. von Ihering, 1877, pp. 31-42.

of an œsophageal ring with one cerebral and two pedal (infra-œsophageal, Tullb.) ganglia.

Family I. *Solenopodidæ*, K. & D.

(*Neomeniade*, Ihering.)

Along the ventral surface a furrow, within which the long narrow foot is concealed. Branchiæ filiform.

Genus 1. *SOLENOPUS*, M. Sars, 1868.

Vermiculus, Dalyell, 1853.

Neomenia, T. Tullberg, 1875.

Body cylindrical, with filiform branchiæ at its posterior truncated extremity. Above the branchial cavity in the posterior margin of the mantle a genital pore, and in the bottom of the branchial cavity an anal orifice. Buccal mass thick, muscular, capable of being completely covered by the mantle, which is covered all over with diversely formed calcareous spicules. Along the ventral surface a furrow, in which the foot is concealed.

1. *Solenopus nitidulus*, M. Sars.

Neomenia carinata, T. Tullb.

The body is nearly round, but a little flattened on the ventral surface, 30 millims. long, 10 millims. broad. Back convex, furnished with a keel. The ventral surface has a furrow, which is formed by the lateral margins of the mantle, and commences 6 millims. from the anterior extremity of the animal, and extends towards the posterior extremity, terminating 8 millims. from the latter. In the bottom of this furrow lies the foot, the anterior part of which is thick, round, 3 millims. in breadth, and becomes narrower and narrower as it approaches the animal's posterior extremity. The lateral margins of the mantle can shut close together; and then only a fine stria is visible; whilst when they separate from each other the furrow becomes tolerably broad, and then the foot comes into view. In the anterior part, towards the ventral surface, the mantle forms a longitudinal fissure, which can expand and contract; within this there is a cavity, surrounded by a fold of skin, which is broader towards the sides, narrower anteriorly and posteriorly. In the bottom of the cavity, somewhat posteriorly, appears the round buccal aperture. At the posterior extremity, likewise towards the ventral surface, there is also a fissure in the mantle, which can expand and

contract, and forms the proper entrance to the branchial cavity. This is ovate from behind forwards, 6 millims. in length and 4 millims. broad in the middle. The branchiæ are arranged in the form of an oblong circle, consisting of thirty filiform tubules, of which those nearest the back are the longest, and those towards the ventral surface are extremely short. At the bottom of the branchial cavity is the round anal orifice. Above and behind the branchial cavity, exactly upon its margin towards the dorsal surface, there is a thick round papilla, in the middle of which is a fine aperture for the generative organs.

The skin or mantle, which is thick and firm, is beset all over with numerous calcareous spicules, which give it a shining appearance. These calcareous spicules are of four different forms: on the dorsal keel they are alternately spear-shaped, lancet-shaped, and needle-like; on the rest of the mantle they are lancet- and needle-shaped. The skin is covered with a single layer of cylindrical epithelial cells, in the midst of which there are, at tolerably regular distances apart, large round cells, which project above the level of the rest of the epithelium, and are filled with a granular mass. These are probably unicellular mucus-glands, and are most likely the bodies described by Tullberg as warts in the skin. Beneath the epithelium the mantle consists of a homogeneous tissue, in which a fine striation may be detected here and there. Imbedded in it are vessels, muscles, and nerves. The vessels are tolerably numerous, partly empty, partly filled with detached oblong cells; in many places they run into pointed canals, terminating cæcally, which are completely filled with a granular protoplasm. The muscles run partly in bundles, partly as single fibres in all directions; only towards the inner surface are they somewhat regularly arranged in longitudinal and annular positions.

Alimentary Organs.

The buccal mass is thick and muscular, and has anteriorly a round aperture without teeth, from which start two long cushions, which project down into the œsophagus; the latter is tolerably wide in the middle, but where it passes into the stomach it is narrowed and surrounded by a sphincter. The stomach occupies nearly the whole of the body-cavity; its walls are firmly affixed to the mantle, except above, along the back, where the genital gland is placed between the mantle and the stomach. Its inner surface is strongly folded. The folds are broadest in the middle, between the dorsal and

ventral surfaces, where they form leaf-like processes. In its walls there are many large round cells, the contents of which consist of fine dark granules (hepatic cells). Towards the hinder part of the body the stomach contracts considerably, as it passes into a short intestine, which opens into the branchial cavity. The whole of the inner surface of the alimentary canal is furnished with ciliated epithelium.

Circulatory Apparatus.

In the posterior end of the body there is between the mantle and the intestine (rectum) a space in which the heart is situated. Into its hinder margin opens the common stem of two vessels, which come from the still more posteriorly situated branchiæ; and from the anterior end issues a single vessel, which passes into the mantle above the posterior termination of the genital gland, and at once begins to ramify. Along the middle line of the belly, just above the course of the mantle-furrow, runs a vessel which we have been unable to trace.

Generative Organs.

Along the dorsal surface of the animal, in the same direction as the keel, and between the latter and the stomach, lies the hermaphrodite gland, which is lobate, consists of a number of acini, and has in the middle a tolerably wide efferent duct. When this has come a little way out of the gland, it divides into oviduct and *vas deferens*. Into the oviduct open the efferent ducts of the albumen-gland, which is three-lobed and oblong. As regards the *vas deferens*, we have reason to think that it divides, but cannot state any thing with certainty upon this point; for we have seen the connexion between the *vas deferens* and the penis-sheath only on one side, without being able to observe any division. On each side of the vestibulum there opens in its lateral margin a penis-sheath, which is extraordinarily muscular, and is clothed inside with cylinder-epithelium. Each of these sheaths encloses a compressed horny sheath, which is open along one margin, and at the posterior extremity beset with numerous small appendages; within this sheath, again, lies the true style (penis), which is likewise compressed, and terminates in a sharp point. The vestibulum is tolerably wide, with firm walls clothed with ciliated epithelium; and into it, besides the two penis-sheaths already described, there opens a small oblong vesicle with a short efferent duct (*receptaculum seminis*), as well as two looped mucus-glands with a common duct. The little oblong

vesicle was filled with a cream-like fluid, in which spermatozooids swarmed. In the hermaphrodite gland we have seen both spermatozooids and ova in different stages of development, but at different times.

With regard to the nervous system, we may for the present confine ourselves to confirming Tullberg's statements about it in essential points. Future investigations will probably carry us somewhat further.

Colour. Body light rose-red, with a greyish tinge, which has a pearly lustre and is somewhat iridescent. Branchiæ bright red. Foot and buccal mass red.

When the animal is brought up from the bottom and kept in a glass for observation, it generally lies quite quiet and somewhat rolled up, like a small thick worm, showing small signs of life. But it may happen that it begins to move: the margins of the mantle are thrown apart, and the foot comes forth; and then it can creep up over the surface of the vessel with great quickness, just like other mollusks; nay, sometimes it floats at the surface of the water, the back being turned downwards and the crooked foot upwards.

Habitat. Near Eivindvig (Sognefjord), at a depth of 60 fathoms by Koren in 1846; near Manger, a few years later, by M. Sars, 300 fathoms; near Lofoten, by G. O. Sars; Moldefjord, 60 fathoms, and in Korstfjord, at 200 fathoms, by Koren and Danielssen, but only single examples. It appears to be extremely rare near the Norwegian coast. In Bohuslehn it is found by J. Lovén and T. Tullberg; but here also it seems to be rare.

2. *Solenopus affinis*, Kor. & Dan.

Body somewhat curved in the direction of its length, furnished along the back with a very high keel, 16 millims. long, 6 millims. broad, 6 millims. in height, of which the keel makes 2 millims. Mantle beset all over with calcareous spicules. It somewhat resembles *S. nitidulus*, but has a much more elevated and prominent keel.

Habitat. Messina (Prof. G. O. Sars), 20–30 fathoms; only a single example.

3. *Solenopus Dalyellii*, Kor. & Dan.

Vermiculus crassus, Dalyell?

Body round, thick, somewhat elongate; back convex, without a keel; belly flat. The largest specimen 20 millims. long, 7 millims. broad in the middle; towards the anterior

extremity it decreases in thickness; the posterior extremity obliquely truncated. Calcareous spicules all over the body.

Habitat. Lofoten, 2–300 fathoms, Hasvig (Finmark), 60–150 fathoms (Prof. G. O. Sars); Sondfjord, 100 fathoms (Koren). Station 79 (Norwegian Atlantic expedition), lat. $64^{\circ} 9' N.$, long. $6^{\circ} 6'$, 157 fathoms. Temperature $46^{\circ} 22 F.$ Clayey sand.

4. *Solenopus incrustatus*, Kor. & Dan.

Body cylindrical, 30 millims. long, 3 millims. broad, pointed towards the anterior, truncate at the posterior extremity, strongly incrustated with particles of sand, so that it has a rugged appearance. Mantle destitute of the spear-shaped calcareous spicules along the back.

Habitat. Hasvig, Finmark, 2–300 fathoms (Prof. G. O. Sars).

5. *Solenopus margaritaceus*, Kor. & Dan.

Body round, thick, strongly glistening, pointed towards the anterior extremity, almost transversely cut off at the hinder end, 12 millims. long, 1.5 millim. in thickness at the broader posterior extremity. Mantle covered with needle- and lancet-like calcareous spicules.

Habitat. Hvidingsøerne, Stavanger, 40–60 fathoms (Prof. G. O. Sars).

6. *Solenopus borealis*, Kor. & Dan.

Body cylindrical, 25 millims. long, 3 millims. broad, rounded and rather narrower at the anterior end, truncate at the hinder extremity, and incrustated with sand. Along the whole of the back runs a rather fine but sharp line, which is but slightly elevated, and richly beset with short, thick, needle-shaped calcareous spicules.

Habitat. Lofoten, 40–50 fathoms (Prof. G. O. Sars). Station 18 (Norwegian Atlantic expedition, Danielssen), lat. $62^{\circ} 8' N.$, long. $1^{\circ} 8'$, 400 fathoms, clayey sand. Temperature $29^{\circ} 66 F.$

7. *Solenopus Sarsii*, Kor. & Dan.

Body cylindrical, 70 millims. long, 3 millims. broad; the hinder end cut off transversely, the anterior prolonged like a beak.

Habitat. Christianiafjord, 100–200 fathoms (Prof. G. O. Sars).